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Emmons, A. B.

On some phonolites from Velay and the Westerwald. 1874.

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ON SOME PHONOLITES

FROM

VELAY AND THE WESTERWALD

BY

o
A. B. EMMONS.
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DISSERTATION

FOR THE

DEGREE OF DOCTOR OF PHILOSOPHY

AT THE

UNIVERSITY OF LEIPSIC

AUGUST 1874.

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A hurried visit last fall to the volcanic district of Velay in Central France, which unfortunately was much interrupted and curtailed by unfavorable weather, owing to the lateness of the season, gave rise to a microscopic and chemical examination of the phonolite rocks occurring there, which I will preface with a few indications of the geological relations of that neigborhood, which, as it would appear, is not very well known, although so interesting geologically, and possessing such great natural beauties of scenery.

The literature on this neighborhood is meagre and of a very general character. The earliest works on it are those of Desmaret and Faujas St. Fond, which are principally of value as having been serviecable in establishing the fact, that active volcanoes have really ce/ once existed in the centre of France. Faujas St. Fond in his work «Des Volcans éteints du Vivarais et Velay», Paris 1778, confines himself almost entirely to the volcanic remains of the Bas Vivarais and touches but very cursorily on those of Velay. The existence of extinct Volcanoes in France was first discovered by two members of the Academy of Paris in the year 1751. They were returning from Italy where they had visited Vesuvius, and had thus had an opportunity of studying the products of volcanic activity, when they stopped by chance at the little town of Montélimart, situated on the left bank of the Rhone. Their attention was attracted by the pavement of the streets, consisting of sections of basaltic columns and on enquiry they learned, that such rocks were very common in the neighboring mountains of Vivarais. This induced them to visit these mountains, and they continued their observations through the Auvergne as far as Clermont, having their suspicions confirmed at every step that the country through which they were passing had once been the scene of volcanic action. On their return to Paris they published their discovery, which however obtained but little credence, and it was only after

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some years, and the publications of the two Savants above named that the fact was estabished beyoud all doubt. Later appeared various papers and memoirs by Dolomieu, Cordier, Lacoste and others relating to the volcanic remains of Velay, but the first, and in fact the only in any way detailed or complete account of them, was given by Bertrand Roux in his «Description géognostique des environs du Puy en Velay», Paris 1823, for that time a very good work for which a prize was awarded by the Institute of France. It contains a map giving with tolerable accuracy the relative distribution of basalt and phonolite. About five years later Scrope brought out his work, «The extinct volcanoes of Central France», London 1828, which contains a great many panoramic views and sketches together with maps of the country, but it treats more specially of the volcanic formations of the Auvergne, only a short mention being made of the phonolites of Velay. Burat's work «Description des Terrains volcaniques de la France Centrale», Paris 1833, is a comparative description of the three volcanic districts of central France, the Auvergne, the Cantal, and the Velay and gives but an outline of their individual geological relations. The latest publication relative to this subject is that of Pascal «Etude geologique du Velay», Paris 1865, which however is little more than a popular description of the general Geology of that part of the country without particular reference to the volcanic remains, and contains nothing of value not already to be found in Bertrand Roux.

Bertrand Roux divides the volcanic formations of Velay into two classes, the basaltic (terrain basaltique) and the trachytique (terrain trachytique). The former which is very much more extensive than the trachytic territory he divides, according to their supposed relative age, into a younger, an older, and an intermediary formation.

The younger formation is composed by a chain of Cones resting directy on the granite-gneiss plateau of Central France, and extending in a southeasterly direction between the Loire and the Allier from Allegre as far south as Pradelles. They are over a hundred and fifty in number and are composed almost entirely of scoriae, ashes and bombs. The numerous lava currents which they produced flowed according to the slope of the plateau into the Loire on the east or into the Allier on the west. Scrope considers this chain as constituting a prolongation of the chain of Puys in the Auvergne. The older basalt formation forms a vast plateau to the north and east of Mt. Mezenc, sometimes filling up the valleys between the phonolitic domes. The more isolated masses lying between Issingeaux and Beaulieu are also included in this formation. Between these two groups lie several other volcanoes which constitute the intermediary group so separated by Roux apparently as much owing to their position as to their supposed difference in age as in the latter respect some may be considered as belonging to the younger and others to the older formation~~s~~.

Owing to the piles of débris collected at the bases of the phonolitic domes, the lines of contact between these and the older basalts are not visible, so that positive proofs of the relative ages of these two rocks are rare. Bertrand Roux and Burat are both decided in their opinion that the eruption of the basalt took place after that of the phonolite and cite as conclusive the instance of a stream of basalt in the neighborhood of Fay-le-Froid overlying the phonolite and enclosing fragments of the latter rock. Scrope on the other ha~~r~~d, considers it more probable that the domes of n/ phonolite rest upon basalt, which had flowed over the granitic plateau before their formation Accepting the former conclusion, and there would seem to be no foundation for the latter, the same succession in regard to time of eruption is seen to exist here as in the other two volcanic districts of Central France, as in the Cantal and the Auvergne the basalt everywhere overlies trachyte, though this of course does not exclude the possibility that some of the last eruptions of trachyte may have taken place after some of the oldest basalts had been formed, and, at least in one instance, at the baths of Mt. Dore, the superposition of trachyte to basalt is unquestionable.

The phonolite territory constitutes a disconnected chain of dome-shaped mountains of from twenty-five to thirty miles in length and of varying brea‸th, not exceeding five or six miles, d/ extending from Mt. Madelaine and Mt. Miau~~r~~e just north of the n/ Loire by the villages Bauzac and Roche en Regnier to a little beyond Mt. Mezenc; south of which lie twenty or thirty domes.

Outside of these limits, according to Roux, no trace of trachyte, that is to say phonolite, is to be found in the whole of Velay. Viewed from the valley of the Loire the chain presents a striking a/ and characteristic apperance with its rugged, sharp pointed peaks, its conical shaped domes, and occasional perfectly level-topped plateaus, with almost perpendicular sides, standing singly or in groups, and separated by valleys cut out in basalt or granite.

Some few of these are thickly wooded, but most are barren of vegetation and have a very grey and sombre look. The discontinuity of the chain is very striking, and though many of the mountains touch each other at their bases, each as it were preserves its own individuality entire from its top to its base. Of the few mountains south of Mezenc, all of which lie within the Vivarais, now the Département de l'Ardêche, the sugar-loaf shaped Gerbiers de Joncs is the most important and the second highest of the range, having an elevation of 1562 metres. At its base are the springs which form the source of the river Loire.

Mt. Mezenc, which sometimes gives its name to the whole range, is the highest point, and is situated just between the Velay, the present Département de la Haute Loire, and the Vivarais, so that the boundary line of these two departements passes over it. Its height, according to the measurements of Ramond and Cordier, being 1774 metres or about 5818 feet, it forms the third highest mountain in Central France being only exceeded by the Pic de Sancy in the Mt. Dore and the Plomb de Cantal in the Cantal. l/ These mountains with very few exceptions rest direcy on the elevated granite plateau which at Estables, a village at the foot of Mezenc, reaches a height of 1350 metres (4428 feet) and thus lie above the limits of the tertiary deposits, so that the determination of their age is accompanied with serious difficulty, «an idea of which» Roux observes «may be obtained from the fact that they have been considered successively as being older than the tertiary deposits, and as posterior to the older basalt formation». In some few instances as at l'Emblaves, Mercoeur, and Martouret the phonolite comes in contact with the tertiary deposits, but in only one place, east of the village St. Pierre-Eynac is the phonolite directly overlying the tertiary marl, and even here it may almost be questioned whether the phonolite be not in secondary position, being so broken up. Perhaps the best proof, although in truth a negative one, that the phonolite is of post-tertiary formation consists in the fact that fragments of it are found only in the very latest diluvial deposits.

Concerning the probable origin of these mountains two different views have been expressed. Struck by the great apparent degradation they have undergone, the question suggested itself to Bertrand-Roux whether they had not once been connected so as to form one continuous mass; which he proceeded to answer by a course of reasoning, to him doubtless very conclusive, but which would hardly be considered as necessarily consequential at the present day, namely, «that there would be no further doubt in this respect, as soon as it could be proved that the rocks at the time they were formed were in a fluid or plastic state, as then they must of necessity have formed a continuous mass, which was only subsequently cut up into the present forms by the disintegrating action of the atmosphere» and that they were of igneous origin was placed beyond a doubt by their general crystalline structure, the great number of enclosed crystals, and the close analogy of the latter with those found in the basalt; finally their elevated position above the limits to which water could have reached, which consequently shut out the possibility of their sedimentary origin, for him apparently the only other alternative. All traces of superposition of successive current~~s~~ being wanting, he concluded that this mass must have been erupted, within a sufficiently short space of time for the whole to have been in a fluid state at once. Scrope follows Roux concerning the origin of these mountains and considers the whole range between Mezenc and Mts. Madelaine and Miaune, as the remains of a single enormous current of lava which flowed from Mt. Mezenc and which according to his own estimations must have possessed the enormous dimensions of twenty six miles in length, with an average width of six miles and a depth of at least five hundred feet, being le~~a~~d to this opinion chiefly «by the progresssive declination of this series of phonolitic summits from Mezenc to the bed of the river where they terminate, the two last called Miaune etc.» The progressive declination of these mountains from Mezenc to the Loire where they end, is owing to the declination of the granitic plateau upon which they rest, which is very considerable, the plateau having at the foot of Mezenc, as we have seen, an elevation of 1352 metres, while the elevation of the town of Issingeaux situated near the end of the chain and a little east of the central line, but surrounded by phonolitic peaks, and which rests on granite, is only 835 metres, so that this extensive fall of the plateau would account for the progressive declination if these mountains were of any other origin, as well as if they were the remains of one enormous current. The other view is that expressed by Burat who considers the rocky masses composing this chain as the result of direct volcanic action exerted at a great number of points along the same fissure, the erupted matter assuming around the points of emission a more pointed or flattened form according to its greater or less perfect state of fluidity; that the eruptions took place contemporaneously, and that the forms of the mountains have not changed materially since the time of their eruption.

The theory of Roux and Scrope, that these mountains are the remains of one immense mass degraded to their present form by the action of external influences, is based upon no good grounds and is in direct opposition to all analogy, as wherever phonolite appears whether in single mountains or in groups, it is invariably characterized by the conical dome-shaped forms which it assumes, the origin of which has never been traced to anything else than the result of direct volcanic action. The individuality of these mountains is often confirmed beyond the possibility of a doubt by the conformity of the plates or Laminae of the rock to the outline of the mountain, these lying at all points parallel to the surface so that the mountain is composed as it were of a series of shells one within the other. The amount of rock necessary to fill up the intervening valleys and to bring these mountains up to one level would exceed by many times that of the whole chain as it now exists, and to suppose these immense masses to have been removed by meteoric agency alone (a supposition which would be necessary, these heights being dominated only by the Alps and the elevations of the Cantal and Mt. Dore, on the east and west) within so short a period would be to attribute a distructive power to the atmospheric influence entirely without parallel.

The structure of these rocks is very similar throughout their whole extent. They show a tendency to split in particular directions and the cleavage is so perfect at many points that plates of considerable size and only a few millemetres thickness are readily obtained. These plates are regularly quarried and used in the country about instead of roofing-slate, being known to the peasants as «Lauzes». This cleavage is owing to the parallel disposition of the tabular crystals of sanidine, which is such that the cleavage of the rocks is parallel to the planes of the most perfect cleavage of the crystals, that is to say parallel to their clino-pinacoids ($\infty \underline{P} \infty$). This parallel arrangement of the crystals may be recognized with the unaided eye in some specimens, but is more plainly seen with the aid of the microscope. The lustrous faces of the sanidine crystals give the cleavage surfaces of the rock a bright glistening appearance which is in strong contrast to the total want of lustre on the surfaces of fracture not in accordance with the cleavage. The crystals are not fully developed so as to have a determined form but present rather the appearance of shining spots. On the other fracture surfaces the edges of these crystals are just visible as very fine lines with strong vitreous lustre, arranged lengthwise parallel to each other and to the surfaces of cleavage. With regard to these faces there seemed to be no particular arrangement of the crystals, as they appear in about equal numbers, whatever the direction of the fracture not parallel to the cleavage may be and one is lead to infer, that these fine lines are the cleavage surfaces parallel to the basic-pinacoid, the only face besides the clino-pinacoid, parallel to which a perfect cleavage exists. The absence of determined arrangement of the crystals with regard to these latter faces would account for their occurrence equally on all sides perpendicular to the cleavage of the rock, and at the same time for their comparatively spare occurrence on any one particular fracture surface, as it would be only where the fracture occurred exactly parallel to the plane of the basic-pinacoid of a given crystal, that this cleavage face possessing a glassy lustre, would be formed, and where the fracture did not coincide with the said plane the surface would be without lustre and no indication of an individual crystal would be distinguishable. This conclusion is further supported by examination under the microscope where cross sections of such plates of rock are seen to be composed entirely of long narrow felspar crystals in parallel lines and as they are of uniform size those which are visible to the naked eye cannot owe this to their exceptional dimensions. The direction of the cleavage is different in the different rock masses and by it, to a certain extent, their difference in form are apparently determined. Where it runs horizontally, the form of the mountain is that of a perfectly level plateau with almost perpendicular sides, of which form Mt. Madelaine is one of the best examples. But if it is inclined obliquely towards the summit, the result is one of those sharp conical shaped peaks so common here. Prismatic jointings are not uncommon and in some instances the columns are so perfect that at a short distance one would be inclined to mistake them for basaltic columns, but they have not the smooth faces nor the sharply cut angles of the latter, and are of greater size. When struck with a hammer larger plates of this rock give out a clear ringing tone similar to the ring of an anvil

Before proceeding to the microscopic examination of the rocks it would be perhaps well to consider for a moment for what kind of rock the name of phonolite is used. The name of Clinkstone first used by Werner and in 1801 changed by Klaproth for Phonolite was applied to a rock possessing certain similarities to both trachyte and basalt and forming as it were a connecting link between the two, though much more nearly allied to the former. It was characterized by its laminar structure and the ringing tone it gave out when struck. Fleuriau de Bellevue in 1805 was the first to discover that phonolite on being treated with nitric acid was partially decomposed, gelatinous silica being thrown down, and suggested that mesotype formed a constituent part of the rock. In 1828 Gmelin decomposed a phonolite with hydrochloric acid and analysed the soluble and insoluble parts separately. The results of his analyses led him to the conclusion that the insoluble part was composed of sanidine and the soluble part of a zeolite, either natrolite or mesotype. It is worthy of notice that the very small quantity of sulphuric acid present did not escape this sharp chemist, though that nosean was one of the constituent minerals of the rock was not then suspected. This analysis of Gmelin is interesting as being the first general average analysis of a rock, or «Bausch-Analyse» as it is called in German, which we possess. The occurrence of crystals of nepheline in phonolite, as an accessory constituent, was observed by Breithaupt and Gustav Rose, and as early as 1839 the latter suggested that nepheline might be an ingredient of the soluble part. This suggestion was very much strengthened by the examination of the Bohemian phonolites by Jenzsch who considered the soluble part as being composed of nepheline, but was led to this conclusion by the results of his chemical analyses and the fact that macroscopic crystals of nepheline occurred in some of them, and not because he had actually seen them in the base of the rock, although he had examined portions of it with the aid of the microscope. So that even before the regular microscopic examination of rocks in transmitted light had been introduced, phonolite was regarded as a rock composed of sanidine, nepheline, hornblende, magnetite, and probably a zeolite, and containing also occasionally small plates of mica, and as accessory constituents titanite and in a few instances augite and olivine. The microscopic investigations carried out by Professor Zirkel on a great number of phonolites from different localities, which were published in 1867, confirmed the presence of nepheline in the base as a regular constituent mineral of all phonolites, occurring generally in small but sharply defined hexagonal and rectangular crystals, and also disclosed the fact, that nosean occurred in almost all phonolites. Before that time the presence of this mineral had never even been suspected, and it was known only to occur in two or three peculiar rocks in the Eifel and Laacher-See district, in the Haüynophyry from Mt. Vulture near Melfi, and in several phonolites of the Hegau in Baden, and in these in large crystals visible to the naked eye, so that its supposed distribution was an exceedinghy limited one. Its presence in the phonolites was even doubted afterwards, as Rammelsberg in a paper in the journal of the German Geological society in 1868 on the phonolite from Mt. Tuilière in Mt. Dore, in which Zirkel had already observed nosean microscopically, asserted that at least now there was no nosean in it, as he could not find a trace of sulphuric acid, and considered it doubtful whether the regular crystals in many of the other phonolites, which had been taken for nosean were not in reality blue sodalite. A little later in the year however he sent a short paper to the same journal as a supplement to his earlier analyses, containing the determination of the sulphuric acid of a number of phonolites already analysed by him. There being but eight to ten percent of sulphuric acid in the mineral and the mineral making up but a small part of the rock, it is not surprising that the few hundredths of a percent of sulphuric acid present in it should have escaped notice when not tested for specially.

The only investigations which have as yet been made upon the rocks of Velay, consist of the analyses of two basalts, and of a palagonite tuff from the neighborhood of le Puy, though from their very characteristic habit, the rocks about to be described have always been considered and cited as phonolites. These phonolites possess a firm compact base in which are visible the sanidine crystals already mentioned, and generally also very small, black, prismatic crystals of hornblende. They are usually of a dark greenish or bluish grey colour and go through various shades from that to a bluish white, like the rock from Mt. Plaux which is completely decomposed. With some few exceptions they have a very fresh appearance, and one would never suspect from examining them with the naked eye, that the least decomposition had taken place excepting of course in the white weathered band. This white, earthy crust, the result of weathering is very characteristic of phonolite rocks. It rarely exceeds a few millemetres in thickness, which indicates that this rock is little acted upon by atmospheric influence. Referring to it Gustav Bischof in his «Lehrbuch d. chem. u. physik. Geologie» says «that were it not for the mechanical separation of these rocks into thin plates, they would hardly ever be decomposed». The constituent minerals nepheline and nosean, especially the latter, are easily decomposed; as the microscopic investigations have shown, they having been found to be almost invariably affected in a greater or less degree. A further proof of this is the frequent occurrence of zeolites in the cavities of phonolite rocks, which can only be regarded as the products of decomposition of the constituents of the surrounding rock in which they occur, among which these two must from their chemical composition, as well as their easy decomposability, have taken a principal part. The decomposition of these minerals does not necessarily affect the external appearance of the rock, as is seen in the case of these rocks from Velay. From this it would appear, that up to a certain point phonolite was easily decomposed; upon the alteration of the decomposable silicates into zeolites or zeolite substance, however, the process ceased, and the latter being of a more stable nature, the result was a rock little affected by the action of the atmosphere; which would reconcile the apparently stable nature of phonolite rocks with the content of easily decomposable constituents. Perhaps the great collection of dêbris around the bases of the mountains in Velay which has been looked upon by some geologists as the signs of great degradation, and as pointing to the former connection of these mountains, might be accounted for by this very resistance to the influence of atmospheric action. Boulders, detached from the sides of the mountains by the formation of joints and clefts having rolled to the bottom, have there remained and gradually accumulated owing to this resistance to the weather, where less resisting rocks would have crumbled away and disappeared; so that these great accumulations do not necessarily imply such enormous degradation, as we might at first be inclined to attribute to them, if we did not consider what causes have brought them into their present position, and what could have effected their removal.

For the microscopic investigation of their mineralogical structure, sections of these rocks were prepared from sixteen different localitis lying between Mt. Mezenc and Mt. Madelaine, the e/ most northerly member of this chain. Owing to their laminar structure and their splitting up so readily nito thin plates, most in/ of the sections were ground parallel to the cleavage, though in some cases cross sections were prepared also. In general they are firm though not very hard and admit of a good degree of pellucidity being obtained.

The large crystals of felspar, exclusively sanidine, distributed through the mass, are more or less decomposed upon their edges so that they are no longer sharply defined and separated from the surrounding matrix. In some instances the decomposition has gone so far, that crystals are only to be distinguished by the bright colours which they exhibit between crossed Nicols prisms, in contrast to the mass in which they are embedded. The fresher ones are clear and transparent, though traversed by parallel fractures, generally transverse to the longer axis. Not unfrequently is to be observed how the decomposing fluid has forced itself along these minute crevices, depositing in its course a yellow granular substance, the fluid itself consisting probably of atmospheric moisture containing carbonic acid, and charged with the substances which it has taken up, as it percolated through the rock. Where the decomposition is so far advanced that the individual felspar crystals are no longer to be distinguished even between crossed prisms the felspathic substance is so filled with series of minute fractures, as to present the appearance of a fine weblike network. The light being partially reflected by these microscopic cracks, the section is less transparent at these points, which in consequence appear to the naked eye like white spots. This is particularly the case in the rock from Rocher Tourte. The fresh sanidine crystals enclose more or less impurities in the form of grains of magnetite, minute crystals of nosean, and occasionally acicular prisms of hornblende, which however do not show any regular arrangement parallel to the edges of the enclosing crystals. Owing to this property of enclosing smaller crystals of other minerals, an indication of their having crystallized out after these were formed—, Professor Zirkel in his paper on phonolites, Poggendorff's Annalen CXXXI 1867, has very aptly designated the sanidine crystals as the «antiquity-cabinets» of the phonolites. For in rocks which were so decomposed, that the nepheline crystals were no longer distinguishable in the base, one would be pretty sure to find well preserved proofs of their having been present in the crystals enclosed in the crystals of sanidine, which latter are usually little affected by atmospheric action. Twin crystals twinned according to the Carlsbad law, in which the plane of junction is parallel to the clinopinacoid, and which are characterized by a well defined line dividing the crystal into two parts, which between crossed prisms show different colours, were only observed in those sections which had been ground so as to give a cross section of the rock, that is to say, one not parallel to the cleavage, where however they occurred quite frequently. This fact is another proof, that the sanidine crystals are arranged with their clino-pinacoidal faces parallel to the cleavage of the rock, as sections of the crystals parallel to their clino-pinacoids are the only ones on which the line of junction in the Carlsbad twin would not appear. Very curious is the growth of two felspar crystals into one another as observed in several instances in a section of the rock from Mt. Madelaine, and in each instance, strangely enough, the compound crystal forms one member of a Carlsbad twin. With ordinary transmitted light they present the appearance of a long narrow crystal with the line which shows the plane of junction of the twins, running down the centre. But between crossed prisms, besides showing the usual different colors on either side of the plane of junction, the upper and lower parts of one of the members of the mace are seen to l/ belong to different individual crystals, regularly grafted into one another; four or five long wedge-like tongues, belonging to one crystal extend into the other, and gradually taper to a fine point, while the spaces between them are filled by similarly shaped tongues, belonging to the other crystal. The edges of contact are very sharply defined between crossed prisms; while one crystal polarizes an intense blue, the other is white, and by turning the analyzer partially round, the reverse is the case, so that the ends of these tongues may be distinguished to their very sharpest points. From the points of the tongues of one of the crystals, in one instance, fine lines extended through the lenght of δ th/ the other crystal, which may be a prolongation of these tongues and composed of the same substance, but too thin to show colour between crossed prisms. They do not appear like the striae of twin formation of the triclinic felspars, though the probability of a triclinic felspar and a sanidine growing together in this way would seem greater than of two sanidine crystals doing so. The intergrowth of orthoklase and albite has long been known especially in perthite, and Streng mentions in the «Neues Jahrbuch für Mineralogie 1871» an intergrowth of albite and orthoklase in the graphic granite from Harzburg, where the former extends into the latter in long bands, somewhat as in the instance just mentioned. But unfortunately the occurrences here are too rare to admit of any conclusions being drawn as to the nature of the respective felspars. In the rock from Rocher de Montelusclat, the long prismatic crystals of felspar are frequently arranged in the form of a star, radiating from a common centre in all directions, and presenting a striking effect when examined between crossed m/ prisms. A si/ilar arrangement of the crystals of augite is sometimes observed in basalt. Triclinic felspar is entirely wanting in these rocks, and in fact plagioklase would appear not to occur in the genuine phonolites, its occurrence being confined to those rocks which approach more nearly to the trachytes, and this applies even to a greater extent to the occurrence of olivine.

The nepheline is very much decomposed in all these rocks, and appears as a white semitransparent substance without determined form, the crystal-form being still distinguishable in only one or two of them. Its form is best preserved in the rock from the quarry of Bellecombe, where the outline of some of the crystals is pretty sharply defined, though the substance is of the same decomposed nature. It is particularly the rectangular sections cut parallel to the length of the crystal, which have preserved their form, the six sided sections cut parallel to the base being more decomposed on the edges, so that they have rather a rounded appearance, instead of the sharply defined hexagons, in which this mineral usually occurs. The crystals in this rock were of unusually large size, some of the four sided sections attaining the dimensions of 0,22 × 0,14 millemetres.

Nosean, occurring in almost every one of these rocks, though usually of a much more decomposable nature than nepheline, seems here to have escaped entirely the decomposing influence and is still perfectly fresh, though this may perhaps be accounted for by its occurring in such very minute crystals. It is dispersed throughout the whole rock, appearing inclosed in the large crystals of sanidine as well as in the matrix, in roundish, imperfectly formed crystals, though regular hexagonal and rectangular, forms (this S/ mineral crystallizing in Rhomben-Dodecahedron) are not unfrequent, and both of these forms under favorable circumstances, that is to say, where the section is thin enough, so that there is little or no other mineral substance above or below them, comport themselves in polarized light as perfectly isotropic bodies. They stand out clearly from the felspar substance or the matrix in which they happen to be imbedded, owing to the difference of d/ the powers of refraction of the two substances, that of the nosean, being evidently the greater as proved by its greater brightness though its index of refraction has not yet been determined. They are mostly of perfectly clear substance with a few minute black points lying irregularly around the centre. In some instances this black dust is so thick as to form a perfectly opaque centre, often so filling up the crystal, that but a narrow rim of clear transparent substance remains, and it is only possible on the edge of this black centre, where it thins out a little, to distinguish that it is composed of such minute black points. This is especially the case with the nosean in the rocks from Mt Losegal and Jurence. The S/ average diameter of the crystals is about 0,025 millemetres though many are much smaller and some considerably larger; the latter however are generally of very irregular form.

The hornblende is evenly distributed throughout the rocks in small acicular prisms and minute irregular grains, oft aggregated en/ together in clusters. They are mostly of bright green, the smaller ones of a faint green, colour. Large regularly formed crystals are of rare occurrence. The small prisms are sometimes so arranged parallel to each other, the ends of which, owing to as to form Crystals/ the prisms protruding unequally, are ragged and uneven, having somewhat the appearance of a fringe. In some of the rocks these aggregations do not occur and the minute prisms, evenly distributed through the mass and lying without regularity in all directions have a suggestive resemblance to green moss. In one or two of the rocks the larger hornblende individuals are composed, for the most part, of grains of magnetite which are cemented together by hornblende substance. In that from Mt. Miaune the small grains of hornblende have arranged themselves around the edges of the larger crystals of magnetite forming a broad green band around each. All the large crystals are distinctly dichroitic when tested with a single Nicol's prism.

Augite occurs in only two of these rocks that from Mt. Madelaine and that from Chaumont d'Artites, in both cases associated with hornblende. It is in large clear crystals though sometimes enclosing a good deal of magnetite. In these rocks at least, the assertion made by Möhl in an addres before the convention of Naturalists at Wiesbaden in September of last year, [On the mineralogical structure and classification of phonolites; of this an epitome is given in the first number of the Neues Jahrbuch für Mineralogie for this year 1874, pag. 38,] that augite is of much more frequent occurrence than hornblende in phonolites, an assertion, which is in exact contradiction to all previous macroscopic observation, is not confirmed.

The presence of magnetite is very irregular, being thickly dispersed in small particles throughout some of the rocks as well as occurring in large crystals; more sparsely disseminated in others; and in a number being absent altogether, which latter fact is remarkable, as hitherto magnetite has been found as a constituent of all the phonolites which have been examined. The large crystals as well as the small particles are of very irregular form. Curious is the occurrence in a large magnetite crystal in a section of the rock from Mt. Miaune of three good sized prismatic crystals of apatite, for though very frequently enclosed in other minerals magnetite is rarely found enclosing foreign matter in itself, and apatite is altogether of very rare occurrence in these rocks, a single crystal having been met with only here and there. Where observed, it has been in long prismatic crystals filled with a sort of dust which gives them a bluish tinge. The crystals are traversed by fractures running transversely to the longer axis and corresponding to the basic cleavage A fuller description of this mineral will be given in another place.

Biotite was found in many of the rocks but in such small quantities that it forms a very unimportant constituent. The folia are so minute that they would hardly be observed, were they not grouped together in clusters. These minute plates are crowded together so that they overlap one another or are ranged one behind the other in irregular rows. The single plates are of a light brown color; where the plates are thicker or where there are several overlapping each other the color is of a very deep shade. In both cases they possess very strong dicroitic properties excepting when the visual axis coincides exactly with the optical axis of the crystal, which very rarely occurs.

The very characteristic sharp wedgeshaped crystals of titanite occur only in the rock from Mt. Miaune. They are of a brownish yellow color, and not very transparent, having an almost pearly appearance. They almost invariably enclose grains of magnetite, minute prisms of hornblende and large microlites, which is contrary to the usual mode of occurrence of this mineral, as it is generally remarkably free from all foreign matter and seems to have been among the first to crystallize out. This mineral, which is very characteristic of phonolites as an accessory constituent, was first observed by Cordier in the phonolite from Sanadoire in Mt. Dore and later was found to occur generally in the Bohemian phonolites. August Reuss observed that it occurred especially in the light colored phonolites of Bohemia, and was wanting in the green dark colored ones: Gutberlet found that a similar distinction existed in the Rhön, where only the younger grey colored phonolites contained Titanite.

This would seem to be further supported by these phonolites from Velay which are, with few exceptions, of dark color, as titanite was observed in but one of them, though that the color of the rock is in any way connected with the occurrence of this mineral, is highly improbable.

All signs of glass or amorphous substance are wanting in these rocks, and the matrix seems to be composed entirely of felspathic substance, which, though unindividualized is often filled with those fine netlike fractures so characteristic of the sanidine crystals, and its identity is unmistakable. Between the Nicol's prisms it polarizes yellowish brown and pale blue.

For the chemical analysis the rock from Mt. Miaune was selected as being one of the freshest and perhaps the best adapted to give an idea of the general chemical composition of these rocks. The analysis was carried out in the Laboratory of the university at Heidelberg under the supervision of Geheimrath Bunsen and according to his methods for an ordinary silicate analysis, the rock being fluxed with carbonate of soda, and the alkalies determined in a separate portion after the silica had been driven off with hydrofluoric acid. The sulphuric acid was determined in a portion w/ by itself, three or four grammes of the powdered rock being employed instead of a single gramme, the amount usually taken in a quantitive analysis. A sufficient quantity of carbonate of soda to flux this, was weighed off, a second and equal amount being taken at the same time in order to determine the amount of sulphuric acid in the soda itself, traces of sulphates and sulphites being always present. After fluxing and separating out the silica the sulphuric acid was precipitated out of the boiling filtrate with chloride of Barium; at the same time the second portion of soda having first been treated with hydrochloric acid, evaporated to dryness, and then dissolved in water, equal in amount to the filtrate, was precipitated, also boiling hot. After standing two days the precipitates were filtered, ignited, and weighed, the difference giving the amount of sulphuric acid in the rock. This method is to be preferred to that of decomposing the rock in hot hydrochloric acid and determining the amount of sulphuric acid in the filtrate so obtained, particularly when the nosean occurs in such minute crystals as it does in these rocks; although this mineral is completely decomposed by hydrochloric acid, yet where it is so widely disseminated throughout the whole rock, a great portion of those crystals which are enclosed within the sanidine, rrounded/ will, however finely the rock be powdered, still remain by sanidine substance and consequently escape determination, the felspar being not at all, or in a very slight degree, acted upon by the acid.

l/ The specific gravity was determined in an ordinary Pycnometer the rock being broken into smal pieces instead of being powdered.

The result of the analysis gave the following percentage:

Spec. Gravity = 2,597		Proportion of Oxygen:
$Si\,O_2$	58,51	31,20
$Al_2\,O_3$	19,66	9,17
$Fe_2\,O_3$	3,43	1,02
$Mn\,O$	Trace	
$Ca\,O$	1,53	0,43
$Mg\,O$	0,31	0,12
$K_2\,O$	4,71	0,96
$Na_2\,O$	10,04	2,59
Loss by ignition	1,00	R : Ʀ : Si = 4,11 : 10,20 : 31,20
Total	99,19	O Quotient = 0,461

Sulphuric acid = % 0,27; Titanic acid Trace.

The proportion soluble in Hydrochloric acid amounted to °/₀ 31,33. The separate analysis of the soluble and insoluable parts seemed not to be advisable as the interpretation of the results of the two analyses would be in the highest degree unreliable even if possible at all, and the amount of soluble parts is to a certain degree dependent upon the strength of the acid employed and the length of time the rock is subjected to its action, the other constituents of the rock being always more or less affected.

The analyses of two German phonolites whose chemical composition is similar to that of Mt. Miaune are appended for comparison.

	I	II
SiO_2	59,17	58,04
Al_2O_3	19,74	20,75
Fe_2O_3	3,39	1,80
CaO	0,92	2,82
MgO	0,15	1,08
K_2O	6,45	7,37
Na_2O	8,88	5,02
Loss by ignition	1,18	H_2O 2,92
Total	99,88	100,01

I. From Lausche near Zittau; vom Rath, Zeitschrift d. deutsch. geolog. Gesellschaft 1856 pg. 297.

II. Kostenblatt, also in Bohemia; Rammelsberg. Zeitschrift d. deutsch. geolog. Gesellschaft 1862 pg. 751.

The proportion of oxygen of

	$\dot{R}O$	$\overset{\cdots}{R}$	$\overset{\cdot\cdot}{Si}$	Quotient of O.
I =	4,38	9,22	31,56	°/₀ 0,431
II =	4,17	9,67	30,95	0,447

The amount of sulphuric acid found in a number of phonolites by Rammelsberg and others was:

Olbrück (Vom Rath)		°/₀ 0,70
Hohenkrähen (Gmelin)		0,12
Teplitzer Schlossberg (Rammelsberg)		0,16
Milzeburg	ib.	0,14
	ib.	
Borczen	(Guthke)	0,10

z/ On treatment with acid all these rocks from Velay gelatinise perfectly with the exception of three, those from Mt. Chaumont d'Artites, Mt. Plaux, and Mt. Costaro. The former as we have seen is not a genuine phonolite and the two latter are very much decomposed, especially that from Mt. Costaro, which is quite earthy and friable.

The Phonolites from the Westerwald.

Among the trachytic rocks of the Westerwald in Nassau, which are for the most part grouped together within the country between Selters, Wirges, Dahlen, and Weidenhahn, there occur according to von Dechen (comparative survey of the volcanic phenomena in the Laacher See district and in the Eifel, Zeitschrift der deutsch. geolog. Gesellschaft 1865) three genuine phonolites and eight rocks having the appearance of phonolites (Phonolith-ähnlich) but gelatinising imperfectly when treated with z/ hydrochloric acid. Two of the genuine phonolites and five of the others, for which I am indebted to the kindness of Herr von Dechen, I have examined microscopically and subjoin the results.

The rock from the Mahlberg, one of the genuine phonolites, is a very compact bluish gray rock, in which no crystals are distinguishable even with a simple lens. It has a slightly resinous lustre, and is strongly translucent on the edges, owing to which and to its very splintery fracture, the minute semi-detached splinters appear almost white, which gives it the appearance of being much lighter colored than it in reality is. The white weathered band or crust so characteristic of phonolites shows well on this rock. Its microscopic structure resembles in many respects some of the phonolites from Velay. It is composed entirely of minute crystals and contains none of any size disseminated through the base. The preponderant constituent is felspar which is only indistinctly dissolved into individual crystals even in polarized light. In some places the prismatic crystals of felspar are disposed in parallel order, forming as it were, bands, and are so curved and wound as to present a wavy appearance, resembling at first sight the «microfluctuation» structure, but closer examination shows that no mechanical movement of the crystals has taken place, as they touch one another directly, all intervening magma in which such movement could have occurred being wanting, and that the wavy appearance is caused by the distorted forms of the crystals themselves. A few twin crystals formed according to the Carlsbad law were observed, but all trace of the striae of triclinic felspar was wanting. The hornblende is evenly distributed throughout the rock in small irregular prisms and grains, the larger of which are distinctly dicroitic, and its whole form and manner of occurrence is too characteristic to admit of a doubt as to its identity. The magnetite which is not present in large quantities is in rounded grains mostly of very small size. A granular substance of a brownish yellow colour occurs in small quantities usually collected together in spots and polarizes with slight color. It is a decomposition product doubtless of nosean or nepheline. Neither nosean nor nepheline were observed as such, but that the latter occurs unindividualized in the base is more than probable, considering that the rock gelatinizes perfectly on treatment with acid.

The other phonolite, which is from the Hartenfelser Kopf, is of a dark bluish gray color, and has a compact base through which small lustrous crystals of felspar are disseminated; on the faces of some of these it is possible with the aid of a simple lens to distinguish the twin striae characteristic of trichinic felspar. These felspar crystals are especially visible on surfaces of fracture in certain directions and are wanting on others, which is indicative of a certain parallelism in their arrangement similar to that observed in the phonolites from Velay. Examined under the microscope a section of this rocks presents a perfect confusion of small prisms and microlites, among which are distributed porphyritically a considerable number of large crystals. The felspar crystals which form the larger proportion of these latter are very fresh and sharply defined, but are especially remarkable for the unusually large amount of impurities which they enclose, some being so filled as to be composed in large part of this foreign matter, from which the felspars in phonolites are usually rather free than otherwise. These impurities consist principally of magnetite and small crystals and microlites of augite, with occassional hexagons and prisms of apatite. Few individuals of sanidine occur among the large crystals most of which are plagioklase, showing the striae marked with a clearness not often met with. These striae are also distinguishable on many of the small prisms of felspar of which the base is in part composed. Thus the larger proportion by far of the felspar belongs to the triclinic system. Next to felspar augite is the most important component, making up a large part of the base in the form of microlites and small prismatic crystals which do not often exceed 0,25 × 0,03 mm. in size. They are of a pale green color, and their edges appearing as fine dark lines give them a sharply defined form though their ends are irregular and rarely fully developed. They lie in all directions, often clustered together and overlapping each other. Roundish forms representing horizontal sections of similar crystals are plentifully mingled with the prisms. Between Nicol's prisms they polarize with bright colors. Augite also occurs in numerous large crystals which have a slightly darker shade of color than the smaller ones just described, but which do not exhibit the least trace of dichroism. They are sometimes so traversed with irregular fractures as to present the appearance of being composed of small pieces and frequently enclose grains of magnetite in considerable numbers.

When examined with the naked eye, thin sections of this rock are seen to contain a number of long black prismatic forms, often attaining a length of several millemetres, which from their shape one would at once betaken for crystals of hornblende or augite. Under the microscope they prove to be composed of minute opaque black grains, perhaps of magnetite, closely aggregated together, the intervening space being filled with a greenish or brownish substance in which they appear to be imbedded. This substance often polarizes in bright colours, but is in no instance dichroitic. These pseudo-crystals sometimes enclose large crystals of magnetite or augite, but appear to have a special affinity for apatite, numerous crystals of which are enclosed in almost every one of them and often several also are seen lying in close contact to the outer edges. This accumulation of the apatite crystals is very remarkable, as it is of too regular occurrence to be considered as the result of accident, and, though crystals of this mineral are found distributed throughout the rock, in no other instance do several occur grouped together as in these crystals. Apatite is observed to occur unequally in rocks, here in considerable quantities and there wanting altogether as though, as Zirkel has suggested, the phosporic acid had originally not been equally dispersed through the magma; but here it would seem as though the grouping had been governed by some determinate cause. These strange aggregations seem to be closely allied to, and as it were, to represent a further developed phase. of, those crystals of hornblende, and also augite, not unfrequently met with, where the outer edges are formed by a narrower or broader band of these black grains closely aggregated together, and in which this band sometimes so predominates that only a mere kernel of the clear crystal-substance is left. These formations have been looked upon as crystals which, having crystallized out early, and being still surrounded by the molten mass, have been acted on and altered from without, an alteration which in some instances has extended to the heart of the crystal; they have also been considered as analogous to those occurrences commonly known as crystallized sandstone, where the crystallizing force of carbonate of lime has sufficed to coerce a quantity of sand equal to double its own amount into the perfectly developed crystalforms of calcite. These crystals are not confined to the younger trachytes and andesites but occurr not unfrequently in the older porphyries.

Apatite occurs in very considerable quantities in this rock and is characterized by the unusual size which its crystals attain; one was observed which was actually over three millemetres long by one in breadth. — They have a slightly bluish tinge which is a shade darker in the hexagonal sections than in those cut parallel to the length of the crystal. The crystals are filled with, what under strong magnifying powers appear to be long hollow pores running parallel to the length of the crystal; and these are so close together in some of the crystals, for example in the large one above referred to, that only in a few places are they transparent. This structure differs considerably from that usually observed and from anything I have seen described of this mineral. Some of the crystals, though filled out to the sides with these pores, are composed of clear transparent substance at the ends. In the hexagonal sections the ends of these pores appear as black points, which together with the bluish tinge of color gives them a striking resemblance to those noseans which are filled with the black dust so common in this mineral. The sections parallel to the length of the crystal are thickly traversed, transversely to the longer axis, by fractures corresponding to the basic cleavage of this mineral. The prismatic sections here very much exceed in number the hexagonal so that had the rock sections been by chance ground in a direction perpendicular to that in which they were prepared, the reverse would have been the case and it can easily be imagined that under such circumstances these slightly bluish tinged hexagons, filled with black points or dust should have been mistaken for nosean. The hexagonal section of a crystal similar in size to the one above referred to, that is of over a millimetre in diameter, — such a section was observed in another rock from this district to be described later, — apart from its strong resemblance to nosean, would escape suspicion of its being apatite from its very size. In fact, in a short epitome of an address held before the convention of Naturalists at Wiesbaden in September 1873 «On the crystalline rocks of Nassau» J. Sandberger cites the phonolite from the Hartenfelser Kopf as containing unusually fine nosean. Möhl in his paper on phonolites, already referred to, also mentions this rock as containing nosean, of which however there is not a trace.

Magnetite occurs in a few large crystals, and in small grains is thickly dispersed through the base of the rock.

This rock contained such an unusually large amount of apatite that I was induced to determine the amount of phosporic acid in it, and found it to be 1,62 per cent, which is very high, the highest amounts given anywhere in either trachyte or phonolite being in the phonolite from Nestomitz near Aussig in Bohemia, 0,29 per cent, (Jenzsch, Zeitschrift der deutsch. geolog. Gesellschaft 1856) and in the phonolite from Erdhalde near Bötzingen in Baden, 0,11 per cent (G. Leonhard, Beitrag zur miner. Kenntniss von Baden 1854—59).

No trace of nepheline was observed in this rock though its gelatinizing so perfectly on treatment with acid, would make it more than probable that unindividualized nepheline was contained in the base The large content of triclinic felspar and augite would seem to exclude this rock notwithstanding its perfect gelatinizing, from being counted among the genuine phonolites, which are characterized by sanidine and hornblende as predominant constituents.

Of the rocks designated by von Dechen as similar to phonolite (Phonolith-ähnlich) those which I examined, were from the Stockhohn near Zürbach, Hähnchen north-east of Nieder-Elbert, Scheidchen near Oberötzingen and the hill south of the Dahlener trachyte quarry.

The microscopic structure of these several rocks is very similar, and is characterized by the minute size of the constituent crystals and the almost total absence of larger crystals distributed porphyritically through this fine crystalline mass. They are composed of minute prisms and microlites of augite imbedded in a clear, transparent, and apparently unindividualized base, which however between crossed prisms, dissolves itself into small well defined prismatic crystals of felspar, on very many of which it is possible to distinguish several fine, differently colored lines, caused by the triclinic twin formation. In sections of one of the rocks in which the crystals were a little larger these striae appeared on most all of the felspar crystals. Very thickly distributed through this mass are minute black grains, for the most part probably magnetite, though, that they partially consist of titanic iron is shown by the characteristic rhomboidal form of some of the larger grains. That these minute prisms have been considered as augite is not owing to any direct proof that they are not hornblende, as they are too minute to admit of their being tested with regard to their dichroitic properties, and too imperfectly formed for conclusions to be drawn from their angles, but rather to their whole general appearance, which is much more that of augite than of hornblende, and to the fact, that several large crystals of unmistakable augite do occur among the very few large crystals observed in these rocks, whilst the only trace of hornblende consists in one of those singular crystals composed of black grains; the centre of this crystal is of clear dark brown substance, which is strongly dichroitic, and is probably hornblende: further to the exact resemblance of these minute prisms to those which occur in the base of the rock from the Hartenfelser Kopf, which are undoubtedly augite. Some idea of the extremely rare occurrence of larger crystals in these rocks may be gathered from the fact, that in seven different thin sections of the rock from the Stockhohn the only ones observed were three larger crystals of magnetite, two of apatite and one of augite. It was in one of the sections of this rock that the large hexagonal cut of an apatite, before referred to, crystal occurs. It is of a bluish tinge of color, and but slightly transparent, owing to its being thickly filled with the ends of the minute pores above described, which have the appearance of black points: is traversed by several large fractures, measures 1,28 mm in diameter, and certainly strongly resembles a large hexagon of nosean. Besides remains of two other such large crystals of apatite, portions of which dropped out in the grinding down of the sections, a few minute prisms of this mineral were observed scattered through these rocks.

The exact classification of these rocks will have to be left to the results of their chemical analyses, though, that they cannot be included among the phonolites, is evident from their being composed principally of plagioklase and augite which places them nearer the basalts apart from their not gelatinising on treatment with acid, and the total absence of nepheline and nosean.

The fifth of these rocks, that from the Cölschhäuser Kuppe, is seen under the microscope to be a genuine felspar basalt containing a great number of large irregularly shaped grains of olivine and crystals of triclinic felspar, disseminated through a compact base of felspar and magnetite.

Together with the foregoing rocks from the Westerwald, the rock which forms the Selberg near Quiddelbach in the Eifel was also examined microscopically. This rock, for which I am also indebted to von Dechen, was formerly described macroscopically by Zirkel, in a paper on the trachytic rocks of the Eifel (Zeitschrift der deutsch. geolog. Gesellschaft 1859), giving also the determinations of its specific gravity and proportion of soluable parts. The base of the rock is of a dark blueish gray color, and contains imbedded in it strongly lustrous crystals of hornblende and small crystals of felspar. The hornblende crystals possess a very perfect cleavage and sometimes attain a length of over ten millemetres. As accessory minerals, olivine and sphen were frequently observed, and much less frequently zirkon. The proportion of this rock soluble in hydrochloric acid is 39,18 per cent. Its specific gravity owing to the content of hornblende, decreasing towards the summit, varies from 2,928 at the base to 2,563 at the summit. On account of this high specific gravity, considering its large proportion of soluble parts, as in phonolites the specific gravity decreases in proportion as the degree of solubility increases, according to which its specific gravity should range somewhere between 2,504 and 2,548, together with its external appearance, Zirkel was induced to consider this rock as a trachyte notwithstanding that the percentage of soluble parts was so unusually high for a trachyte. Von Dechen in his paper on the Laacher See and Eifel already referred to, considers this as a phonolite and cites it as the only phonolite occurring in the Eifel. It is also cited by Mitscherlich as a phonolite, in his work «Ueber die vulkanischen Erscheinungen der Eifel» edited by Roth 1865.

Under the microscope the base of this rock is seen to be composed of minute crystals of felspar and microlites of hornblende or augite and grains of magnetite, the former however composing much the larger part. The outlines of the individual felspar crystals are often not clearly defined even between crossed Nicols. Very sparsely disseminated through this mass are to be observed exceedingly minute hexagonal and rectangular forms, most plainly to be seen in the larger crystals of felspar, but nowhere in large numbers, and only visible in the very thin portions of the sections. One or two larger ones of rectangular form were distinctly isotropic between crossed Nicols, and contained a very minute series of dark lines in the centre, so that I am inclined to consider these minute forms as belonging to the mineral nosean. These and the smaller of the similar forms observed in the phonolites from Velay may be considered as bearing a ~~similar~~ relation to nosean ~~like~~ similar to that which the respective microlites of felspar, hornblende, and augite, bear to those minerals. A yellowish and but slightly translucent substance which occurs sometimes in portions of considerable size is evidently the product of decomposition of the larger nosean crystals, as partially preserved portions of the crystals are in several instances distinctly re-cognizable.

The large crystals of felspar, which however are not very numerous, show almost without exception the polysynthetic structure of the triclinic felspars, and their substance is very fresh and free from enclosed foreign matter. The hornblende is of a deep brown color and strongly dichroitic when examined through a single Nicol. Sections cut perpendicular to the main axis are not unfrequent, showing perfecty the characteristic angle of 124° made by the two prism faces. The crystals are all bounded by a black border formed partly by decomposition and partly by the accumulation of minute grains resembling magnetite around and within the edges. This border is generally of inconsiderable width, but in the cases of a few long narrow prisms the whole crystal is composed of such grains; except in these cases the interior of the crystals is generally composed of perfectly clear substance. Remarkable is the occurrence of small prisms and hexagons of apatite enclosed within or accumulated around crystals of hornblende, a mineral, which is otherwise rarely met with in this rock.

Augite which makes up almost as important a constituent as the hornblende occurs in well defined crystals generally of a bright green color, more rarely of a pale, almost violet, tinge. On some sections may be plainly observed the angle almost equal to a right angle, made by the prism faces and modified by the ortho-pinacoid as usually occurs in separate crystals of this mineral. A most excellent opportunity is here afforded for studying the distinguishing characteristics of these two minerals which do not frequently occur together in the same rock, hornblende occurring mostly in the acidic rocks while augite is more confined to the basic rocks: though there being no fixed line of separation between these two classes, the one passing gradually into the other, it would be perhaps to be expected that in those rocks which form, as it were, the connecting link between the two, and which can as well be regarded as forming the highest members of one class as the lowest members of the other, these two minerals should occur together.

Large crystals of nosean are not unfrequent; they are of a greyish color and filled with that fine dust so characteristic of this mineral. Most of the crystals are considerably decomposed and accordingly between crossed Nicols comport themselves as double refractive bodies. A few crystals of olivine were observed, the substance of which was still quite fresh and clear, though decomposition had attacked the outer edges and the edges of the fractures traversing the crystals through the centre, and altered them into green serpentine the end product of decomposition of this mineral. Being of so seldom occurrence it plays but a very unimportant part in the composition of this rock, and can only be considered as an accessory constituent. Small yellowish crystals of titanite of the characteristic wedge like form occur, but, as is usual with this mineral, have a very limited distribution.

G. von Rath in the «Correspondenzblatt der zweiten Hälfte der Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande und Westphalens» 1866 page 46, mentions a new occurrence of the mineral leucite in the Rheinish volcanic district and cites the rock from the Selberg near Quiddelbach as being composed of leucite, sanidine, hornblende, augite, and titanite, for which he proposes the provisional name of Leucite-phonolite. Although I examined a number of thin sections of this rock I was unable to find a trace of leucite in it, and can only conclude that the roundish sections of nosean, which crystallizing in the Tesseral system, as leucite was then supposed to do, is a single refracting body, must have been mistaken for it, which is all the more probable as at that time the microscopic diagnosis of nosean was not yet known.

This rock must be classed with those from Roche Sanadoire in Mt. Dore and from Salesl in Bohemia among the trachytic Phonolites, as the large contents of Augite, together with the triclinic felspar and its usual companion olivine, remove it from the genuine phonolites, while on the other hand the proportion of soluble parts is too high for it to find a place among the trachytes.

The repeated occurrence of the combination of plagioklase and nepheline associated on the one hand with augite, and on the other with hornblende, is worthy the attention of Lithologists It would seem as though we had here to deal with a new species of rock not yet recognized as such, though of wide distribution and differing materially as well from the genuine phonolite, composed of sanidine with little or no plagioklase and hornblende, as from the nephelinite composed of nepheline and augite, and approaching most nearly, perhaps, to the Buchonite of Sandberger.

In conclusion I beg to express my warm thanks to Professor Zirkel for his kind advice and assistance in the carrying out of these investigations.

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